

Modern Concepts of Cardiovascular Disease

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DR. ARLIE R. BARNES, Rochester, Editor

DR. T. J. DRY, Rochester, Associate Editor

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SURGICAL TREATMENT FOR COARCTATION OF THE AORTA

An *infantile type of coarctation* is that form of constriction with a long segment of narrowing in the distal part of the aortic arch. It is frequently associated with severe intracardiac abnormalities, and it usually leads to fatality in the first year or two of life. In contrast, the *adult type of coarctation* is limited to a short segment of vessel, is usually situated beyond the aortic arch, and lies in the general region of the attachment of the ligamentum arteriosum (or of the ductus arteriosus). It is much less likely to have associated intracardiac deformities and it is compatible with a much longer life than is the case with the infantile form.

Prognosis for untreated patients

A few individuals tolerate an adult type of coarctation in a surprisingly satisfactory manner, but the majority of such patients eventually develop severe symptoms or even fatal complications. In a forthcoming paper,¹ an effort has been made to determine the prognosis for individuals who have coarctation of the aorta and have survived beyond the first two years of life. Such patients could be roughly divided

normality. Most of the cases reviewed during this study were in the pre-penicillin era, and hence, it must be pointed out that modern chemotherapy, particularly with penicillin, can now greatly minimize this hazard.

In the third group were those patients who suddenly died because of rupture of the aorta. While there was usually some degree of hypertension in patients who died of aortic rupture, it is well known that the aorta can rupture even in the absence of increased pressure. If rupture is to occur, it usually does so in the third or fourth decade.

In the fourth group were those patients who died from the effects of the hypertensive state. They have succumbed either from cardiac decompensation or from intracranial hemorrhage. Such fatalities were apt to appear in the third or fourth decade of life.

A study of patients with coarctation of the aorta leaves no doubt that this is an abnormality which brings to its possessor an exceedingly high risk. While some individuals have had a long existence, generally the prognosis beyond the age of twenty-five or thirty years is very poor.

Experimental approach to the surgical problem

The unfavorable outlook for many individuals with coarctation of the aorta has stimulated efforts to find a method for correcting this abnormality by surgical means. Working in the surgical laboratory, and using dogs to develop operative technic, it was found that short segments of the upper thoracic aorta could be excised and that the remaining ends of the aorta were elastic enough so that they could be pulled together and could be joined by end-to-end anastomosis. Various types of suture methods were tried and one was finally adopted in preference to all others. When the ends of the aorta are properly joined by this type of arterial repair, there is absolutely no bleeding at the suture line. The details of this technic have been described elsewhere.¹

Operation for coarctation in human beings

In human subjects, the avenue of exploration has been similar to that previously found to be optimum in dogs. Through a long posterolateral incision, medial to and below the left scapula, the thoracic cage has been opened. The left lung is temporarily collapsed during the operative procedure (but is expanded thereafter). The upper portion of the thoracic aorta is mobilized from its bed, freeing a segment 6 to 7 cm. long. To accomplish this it is necessary to divide two sets of intercostal arteries, the bronchial artery, and a few other accessory vessels. In three cases there was an associated patent ductus arteriosus which required complete division; in the remaining individuals the ligamentum arteriosum was divided to liberate the aortic segment. The aorta above the coarctation has a heaving, intrinsic pulsation, whereas the vessel below the constriction has no intrinsic pulsation. Specially devised clamps are ap-

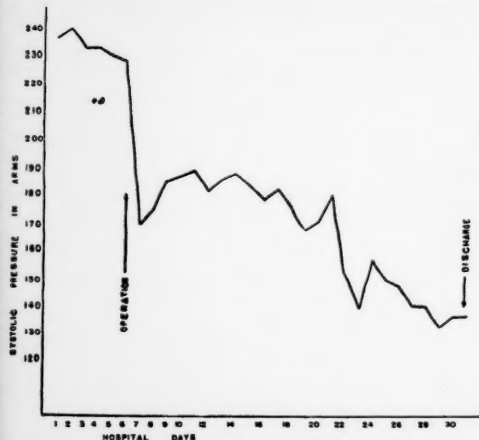


Fig. 1. Chart showing reduction of blood pressure in arms in a boy, ten years of age, following surgical removal of a coarctation of the aorta.

into four groups, each comprising about one quarter of the entire series.

In the first group were those subjects who have attained elderly life and who have few or no symptoms from the aortic lesion. Taken as a whole, these patients have had minor complaints but have had reasonably satisfactory lives.

In the second group were those individuals who succumbed because infection with *Streptococcus viridans* was superimposed on the cardiovascular ab-

plied above and below the constricted area, the narrowed segment is cut out, and the remaining ends of the vessel are then approximated to one another by appropriate suture. After removal of the aortic clamps the lower segment of aorta develops an intrinsic pulsation.

Results of operations

To date sixteen patients have been explored for coarctation of the aorta. In two of these, the conditions of the upper thoracic aorta were such that the strictured area could not be excised—and the operative procedure had to be abandoned. In the first case, the regional vessels were embedded in a dense, fibrous tissue—presumably the result of a burned out infection which had been successfully treated six months previously with penicillin. This patient unfortunately died five days later from renal failure and uremia. In the second individual, the narrowed portion of the aorta was 3 to 4 cm. long and the adjacent portions of the vessel did not seem to have enough elasticity to allow removal of such a long segment and suture of the remaining ends.

In fourteen cases, the narrowed area of aorta was completely excised and the ends of the vessel were brought together for reconstruction of the aortic tube. Two of these patients died. The first expired from a sudden removal of the aortic clamps, which allowed blood to rush down too quickly into the lower part of the body. (In all subsequent cases the clamps have been removed slowly over a period of five or six minutes, so that the readjustments in the circulation could be effected more slowly). The second fatality was in a man thirty years of age who was found to have a high degree of sclerosis in the aorta which made it unsuitable for manipulation and careful suture. This man suddenly died twenty-four hours after operation, presumably from disruption at the suture line. In a third case, a man of twenty years with hypertension, the systolic blood pressure averaging around 200 mm. of mercury, the line of aortic anastomosis was unsatisfactory and an adequate lumen could not be established. While this patient survived the operative procedure, he has had no important alleviation of his hypertensive state.

In the remaining eleven individuals, the removal of the constricted portion of aorta and the anastomosis of the remaining ends of the vessel has been accomplished in a very satisfactory manner and the post-operative result has been extremely gratifying. Hypertension in the upper part of the body has been completely relieved; and simultaneously there has been appearance of normal pulsations and pressures in the arteries of the legs.

Summary

Studies on the prognosis for patients with coarctation of the aorta indicate that in a high percentage of cases this abnormality is likely to be accompanied by severe complications which include superimposed bacterial infection, rupture of the aorta, cardiac decompensation or intracranial hemorrhage. The life expectancy for these patients beyond twenty-five or thirty years of age is very poor.

A method has now been developed whereby the narrowed segment of the aorta can be removed and the continuity of the vessel re-established by anastomosis of the remaining aortic ends. Such steps have been thoroughly tried in the experimental laboratory and have now been adapted for use in human beings. Fourteen patients have been subjected to removal of the constricted segment of the aorta. There were two fatalities and one failure to relieve hypertension. In the remaining eleven individuals there has been a very satisfactory disappearance of the hypertension in the upper part of the body. It seems reasonable to believe that these patients have been spared from rupture of the aorta, from intracranial hemorrhage, and from cardiac decompensation.

Experiences to date would indicate that the optimal ages for performance of this operation lie between six and twenty years. Beyond twenty or twenty-five years the appearance of regional arteriosclerosis makes the aorta a poor vessel for manipulation and suture—and the surgical mortality rate will probably be forbiddingly high. In contrast, younger individuals—up to eighteen or twenty years of age—still have an aorta of suitable thickness and elasticity to permit performance of this operative procedure with a reasonably low surgical risk.

Robert E. Gross, M.D.
Boston, Massachusetts

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